

WELCOME TO THE AIRLINE INDUSTRY

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Welcome to the Airline Industry

- **United has largest Engineering Staff**
 - Approximately 120 Engine Engineers
 - Approximately 700 total Engineers
- **Annual Maintenance Budget for Engines**
Alone is \$500,000,000
 - Looking for Best Bang for the Maintenance \$ Without Compromising Safety

- United has one of the largest technical departments in the airline industry. Overall UAL employs approximately 700 engineers, 120 alone in the jet engine overhaul shop in San Francisco. These engineers are responsible for overseeing the maintenance programs for both the engines and the aircraft.

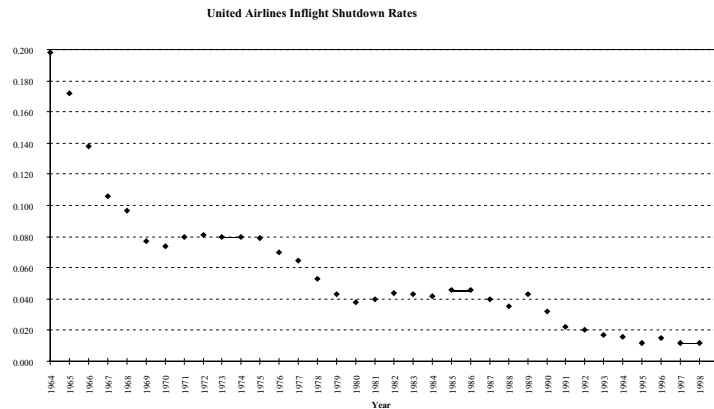
- United overhaul facilities are very capable. UAL can repair their own parts, develop their own repairs and in certain cases, manufacture their own parts. If a part cannot be repaired inhouse, it is sent out to an outside vendor (OSV). A good example of the repair capability is the ability to repair and create new knife edge seals in the flame spray shop.

- The annual maintenance budget for the jet engine overhaul shop alone is \$500,000,000 (this is only for the cost of new and repaired parts). With this money, approximately 650 engines are overhauled yearly. The primary mission for the United engineer is to develop and fine tune maintenance programs in order to increase reliability at minimal cost without sacrificing safety. In other words, to get the biggest bang for the maintenance buck.

- UAL engineer is constantly analyzing the maintenance programs to make sure that whatever amount of money is spend is recouped in increase efficiency and reliability. Particularly when it comes to seals and secondary flow systems. Just by increasing the efficiency of a system, engine or aircraft by a 0.1 to 0.5% means incredible savings to the airline.



IFSD Rate Today!



Example of the good results from some of the hard work. UAL has one of the best safety record and best IFSD record in the industry today.

Here is a chart of the In Flight Shut Down (IFSD) rate starting in 1964 when jet engines were first introduced through 1999. As you can see, we are constantly working to increase the safety and reliability of the fleet.

NOTE: This chart only reflects the IFSD rate of jet engines only.



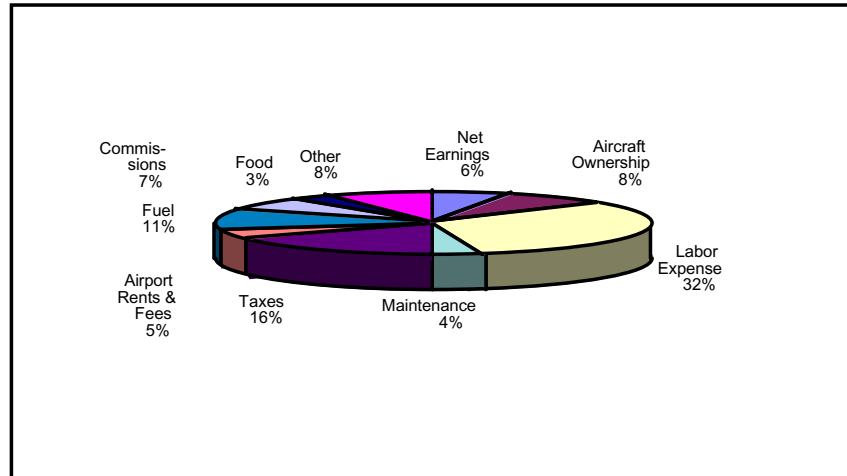
The Bottom Line

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Why would United employ such a large engineering group in the first place. After all UAL could just follow the maintenance programs set out by the OEM's. Admittedly corporate headquarters does look at the engineering department as a money pit or black hole. But they do understand that engineering has a large effect on the bottom line. How do we do this? This is accomplished by actively reducing IFSD, by reducing delays and cancellations on the line and by implementing smart performance improvements which all save money.



Distribution of One U.S. Passenger Dollar



This pie chart represents how your travel dollar is spent. Engineering cannot effect commissions, airport rents and fees, taxes, aircraft ownership or food. But engineering can have a large effect on labor costs, fuel costs and maintenance costs.

Examples:

1) If a more reliable engine gearbox carbon seal is introduced, parts and labor savings can be realized by not having to replace the part on line. Also could save the cost of possible IFSD due to oil loss or the cost of a delay or cancellation due to replacement on the line.

2) Implementing a more durable and efficient engine brush seal would ensure the secondary flow system flows the proper amount of air. There would be no excess leakage and waste of expensive (compressor) air. And reduced premature deterioration of downstream parts.

3) Implementing a more durable engine bleed valve carbon seal again saves money by reducing the leakage and waste of expensive muscle pressure air.



The Need For Effective And Durable Designs

- **Increase η By 1.5% = 1 Cent Reduction In Fuel**
- **1 Cent Reduction In Fuel = \$30 Million In Savings / Year**
- **Increase Durability = Reduction In Premature Removals And Reduced Maintenance Cost**

Let's talk numbers.

If the efficiency of an engine can be increased by 1.5%, that would be equivalent to reducing the price of fuel by \$0.01. Based on the PW4000 engine fleet usage alone, 3 billion gallons of fuel are burned a year. Thus a 1.5% improvement in engine efficiency (PW4000) means a savings of \$30 Million a year. That is over 0.5% of the annual jet overhaul shop maintenance budget. Thus very, very small improvements in performance equals large savings for airlines. We struggle hard to make our fleets 0.5 to 1% better.

Additionally, we can measure improvements in premature removals and reduced maintenance costs by the implementation of more durable designs.



Goals

- **Opportunity To Examine Real Life Experience And To Understand The Overall Picture**
- **Opportunity To Make Large Impact On Airline Operating Cost By Reducing**
 - TSFC Deterioration
 - Premature Overhauls
 - Reduced Line Maintenance
 - Reduced Delays and Cancellations
 - Increase in Safety and Reliability

The seals and secondary air system workshop presents many opportunities. First, it gives an opportunity to examine real life experiences and to understand how new designs can make an impact on the overall picture.

The opportunities exist to make a large impact on the airline industry and reducing operating costs by reducing TSFC deterioration, premature overhauls, line maintenance costs, delays and cancellations and increase safety and reliability.

Last thought for the day. Airline travel is expected to double in the next 20 years. Although statistically speaking it is the safest mode of transportation, at the level of safety we are at today the number of incidents will double. This is not acceptable. An additional goal is to make future designs even safer and more reliable than they are today. Together we can make that happen.